



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number : **0 371 620 B1**

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification :
07.12.94 Bulletin 94/49

(51) Int. Cl.⁵ : **H04R 19/01**

(21) Application number : **89311255.7**

(22) Date of filing : **31.10.89**

(54) **Electret condenser microphone.**

(30) Priority : **30.11.88 JP 302915/88**

(43) Date of publication of application :
06.06.90 Bulletin 90/23

(45) Publication of the grant of the patent :
07.12.94 Bulletin 94/49

(84) Designated Contracting States :
DE FR GB

(56) References cited :
US-A- 3 812 575
US-A- 3 833 770
US-A- 3 946 422
US-A- 3 991 285

(73) Proprietor : **MATSUSHITA ELECTRIC
INDUSTRIAL CO., LTD.**
1006, Oaza Kadoma
Kadoma-shi, Osaka-fu, 571 (JP)

(72) Inventor : **Baba, Hiroyuki**
Iwaki-so D
1284-120 Matagi
Miyamae-ku Kawasaki (JP)

(74) Representative : **Senior, Alan Murray et al**
J.A. KEMP & CO.,
14 South Square,
Gray's Inn
London WC1R 5LX (GB)

EP 0 371 620 B1

Note : Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

Description

The present invention relates to electret condenser microphones for use in various audio equipment, telephones, etc.

Electret condenser microphones are of two basic types: (1) wheel electret, having a vibratory diaphragm formed of an electret; and (2) back electret, having an electret fixed by fusing, for example, to a fixed electrode.

One such prior wheel electret condenser microphone will be described below with reference to Fig. 16 of the accompanying drawings. The wheel electret condenser microphone includes a cup-shaped metallic case 1 having a top end wall 1a with a plurality of sound-receiving apertures 1b. A metal ring 2 is secured to an inner surface of the end wall 1a and a stretched vibratory diaphragm 3 is fixed to an end face of the metal ring 2. The vibratory diaphragm 3 has a deposited metal film 3a on its one surface facing the end face of the metal ring 2. The vibratory diaphragm 3 is separated by a spacer ring 4 from a fixed back plate or counter electrode 5 so that the diaphragm 3 and the counter electrode 5 forms a condenser 6 whose capacity varies with the vibrations of the diaphragm. The counter electrode 5 has pressure-equalizing holes 5a communicating with a rear cavity 7 behind the counter electrode 5 to equalize static pressure across the diaphragm 3. The rear cavity 7 is defined by a cup-shaped insulating support 8, which fixedly supports on its open end the counter electrode 5 and electrically separates the counter electrode 5 from the metallic case 1 and the diaphragm 3. A field-effect transistor (FET) 9 used for impedance conversion is disposed in the rear cavity 7 and electrically connected with the counter electrode 5 via an input lead 9a. The input lead 9a has one end which is either held in contact with the counter electrode 5 or fixed by spot welding to the counter electrode 5. The field-effect transistor 9 has an output lead 9b connected by soldering to a printed-circuit board 10 on which the insulating support 8 is mounted. The printed-circuit board 10 carrying thereon the insulating support 8, the field-effect transistor 9 and the counter electrode 5 is assembled with the cup-shaped metallic case 1 by clinching an open end edge 1c of the metallic case 1 over and around the periphery of the printed-circuit board 10, with all the components 5, 8, 9 received in the metallic case 1.

Fig. 17 is an exploded view of the prior electret condenser microphone shown in Fig. 6, with parts shown upside down for a purpose of illustration of the manner in which the microphone is assembled. The fixed counter electrode 5, the insulating support 8, the field-effect transistor 9 (not shown in this figure as it is mounted in the insulating support 8), and the printed-circuit board 10 are assembled together into a preassembled built-in amplifier block. In assembly,

the metal ring 2 carrying on its upper end face the diaphragm 3, the spacer ring 4, and the amplifier block having the counter electrode 5 facing downward are placed in the cup-shaped metallic case 1 successively in the order named. Then an open end edge of the metallic case 1 is bent into an inwardly curled edge 1c (Fig. 16) firmly clinched over and around the periphery of the printed-circuit board 10. The electret condenser microphone is thus assembled.

With this construction, when the diaphragm 3 of the electret condenser microphone is vibrated by acoustic pressures impinging thereon through the sound-receiving apertures 1b, the diaphragm 3 produces a capacitance change between the diaphragm 3 and the fixed counter electrode 5 of the condenser 6. Since the electrical impedance of the condenser microphone is relatively very high at audio frequencies, a direct current electric field is applied in which instance the field-effect transistor 9 is used as an impedance converter.

As described above, the fixed counter electrode 5 is structurally separated from the metallic case 1 and in order to form a condenser 6 by and between the fixed counter electrode 5 and the vibratory diaphragm 3, the spacer ring 4 must be disposed between the counter electrode 5 and the diaphragm 3. The prior art electret condenser microphone thus constructed has a relatively large number of component parts, is complicated in construction, requires a time-consuming assembly and is costly to manufacture. Furthermore, with this large number of components retained in the case 1, there is provided only a small room available for the formation of the rear cavity 7.

With the foregoing drawbacks of the prior art in view, it is an object of the present invention to provide an electret condenser microphone which has fewer structural components and is simpler in construction and hence can be manufactured at a lower cost.

US-A-3,833,770 discloses a device which uses three electrodes of which the central one is an electret. Previous devices which only used two electrodes had difficulty in eliminating the second harmonics produced. The third electrode used in US-A-3,833,770 eliminates the harmonics generated by the other electrodes. US-A-3,812,575 relates to a procedure for manufacture of an electret microphone.

According to the present invention there is provided an electret condenser microphone comprising a cup-shaped metallic case including an end wall having a plurality of sound-receiving apertures, formed therein a metal ring received in said metallic case, a vibratory diaphragm having on one surface hereof a deposited metal film and bonded to an end face of said metal ring, said vibratory diaphragm confronting said end wall with an air gap defined between at least part of said end wall and at least part of said diaphragm, said metal film forming a movable electrode of a condenser also comprising a fixed counter elec-

trode

characterised in that said fixed counter electrode comprises at least a part of said end wall of said metallic case.

The metal ring need not be a complete ring - other shapes are possible. The opposite end face of the metal ring may have a stepped portion in which an input lead of a field-effect transistor is received and gripped by and between the metal ring and a printed-circuit board on which the field-effect transistor is mounted for impedance conversion.

Since the field-effect transistor may be directly mounted on the printed-circuit board as a single amplifier unit or block, it is no longer necessary to assemble the field-effect transistor with a fixed counter electrode forming a part of the condenser, an insulating support, and the printed-circuit board as in the prior art electret condenser microphone.

Furthermore, the input lead of the field-effect transistor may be electrically connected to the metal ring with utmost ease. With the invention, the electret condenser microphone is simple in construction, can be assembled easily and can be manufactured at lower cost.

The above and other objects, features and advantages of the present invention will become more apparent from the following description when making reference to the detailed description and the accompanying sheets of drawings in which preferred structural embodiments incorporating the principles of the present invention are shown by way of illustrative example.

Fig. 1 is a cross-sectional view of an electret condenser microphone according to the present invention;

Fig. 2 is an exploded view of the electret condenser microphone shown in Fig. 1;

Fig. 3 is an equivalent circuit diagram of the electret condenser microphone of Fig. 1;

Fig. 4 is a perspective view of a tubular metal ring for used in the electret condenser microphone according to a modification of the present invention;

Fig. 5 is an exploded perspective view of another form of the modified tubular metal ring;

Fig. 6 is a perspective view of a modified tubular metal ring formed from a sheet metal;

Fig. 7(a) is a plan view of a sheet metal from which the tubular metal ring of Fig. 6 is formed;

Fig. 7(b) is a front end view of Fig. 7(a);

Fig. 8 is a bottom view of the tubular metal ring shown in Fig. 6, illustrating the manner in which the sheet metal shown in Fig. 7(b) is bent by rolling into a tubular metal ring;

Fig. 9(a) is an enlarged cross-sectional view of a part of the electret condenser microphone shown in Fig. 1;

Fig. 9(b) is a view similar to Fig. 9(a), but showing a modified arrangement of a cup-shaped metallic

case and a tubular metal ring for preventing insulation failure;

Fig. 9(c) is a view similar to Fig. 9(a), but showing another modified arrangement of the metallic case and the tubular metal ring;

Fig. 10 is a cross-sectional view of an electret condenser microphone according to another embodiment of the present invention;

Fig. 11 is a plan view of Fig. 10;

Fig. 12 is an enlarged cross-sectional view of a part of the electret condenser microphone shown in Fig. 10;

Fig. 13 is a cross-sectional view of an electret condenser microphone according to a further embodiment of the present invention;

Fig. 14 is a view similar to Fig. 3, but showing an electret condenser microphone according to still another embodiment;

Fig. 15 is a cross-sectional view of an electret condenser microphone according to another embodiment of the present invention;

Fig. 16 is a cross-sectional view of a prior electret condenser microphone; and

Fig. 17 is an exploded view of the prior electret condenser microphone.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, Fig. 1 shows an electret condenser microphone according to a first embodiment of the present invention.

The electret condenser microphone includes a cup-shaped metallic case 11 made of aluminum, for example, and having an end wall 11a closing one end of the cup-shaped metallic case 11. The end wall 11a has a central recess 11b in its inside surface, which is formed by bulging a central portion 11c of the end wall 11a. The recess 11b has a depth of about several tens μm . The bulged central portion 11c of the end wall 11a has a plurality of sound-receiving apertures 11d for the passage therethrough of sound waves. A tubular metal ring 12 is disposed in the cup-shaped metallic case 11. The metal ring 12 is made of stainless steel for example and supports on its one surface a thin stretched vibratory diaphragm 13. The vibratory diaphragm 13 is formed of a synthetic resin such as fluorinated ethylene propylene and has on its one surface a deposited metal film 13a made of nickel, for example. A peripheral edge portion of the deposited metal film 13a is bonded to the end face of the metal ring 12 to assemble the vibratory diaphragm 13 with the metal ring 12 while the vibratory diaphragm 13 is kept in stretched condition. The metal ring 12 is stepped in its opposite end face so as to form an annular recess 12a facing an internal space of the metal ring 12, the internal space constituting a rear cavity 14 extending behind the vibratory diaphragm 13. A field-effect transistor (FET) 15 used as an impedance conversion element is mounted on a printed-circuit

board 16 and received in the rear cavity 14. The FET 15 has three lead terminals, namely a source terminal (not shown), a drain terminal 15a, and a gate terminal 15b. The source terminal and the drain terminal 15a of FET 15 extends through holes in the printed-circuit board 16 and are soldered (as at 17) to conductors formed on the under surface of the printed-circuit board 16. The gate terminal 15b of FET 15 is received in the recess 12a of the metal ring 12 and gripped by and between the metal ring 12 and the printed-circuit board 16. The gate terminal 15b thus retained is electrically connected to the deposited metal film 13a of the vibratory diaphragm 13 via the metal ring 12. The printed-circuit board 16 is received in the cup-shaped case 11 and assembled with the latter by an inwardly curled open end edge 11e firmly clinched over and around a peripheral edge of the printed-circuit board 16.

With this construction, the bulged central portion 11c of the end wall 11a constitutes a fixed electrode of a variable capacitor or condenser 18, a movable electrode of the condenser 18 being formed by the vibratory diaphragm 13 disposed immediately below the bulged central portion 11c and separated therefrom by an air gap 19 defined by the recess 11b in the end wall 11a. The arrangement of the movable and fixed electrodes 13, 11c of the condenser 18 is opposite to the arrangement of the movable and fixed electrodes 3, 5 of the condenser 6 of the prior electret condenser microphone shown in Fig. 16. Since the air gap 19 is communicated with the outside air through the sound-receiving apertures 11d, the sound-receiving apertures 11d may lower a shield effect against induction noises such as a hum. However, the present inventors have experimentally confirmed the fact that the noise shield characteristic of the condenser microphone does not change when the electret condenser microphone of about 10 mm diameter is provided with 6 (six) or less number of sound-receiving apertures 11d having a diameter of about 0.5 mm.

The electret condenser microphone of the foregoing construction is assembled as follows. After the vibratory diaphragm 13 is bonded to one end face of the tubular metal ring 12, an amplifier unit or block composed of the FET 15 mounted on the printed-circuit board 16 is secured to an opposite end face of the tubular metal ring 12, with the FET 15 received in an internal space of the metal ring 12, as shown in Fig. 2. Then, the metal ring 15 assembled with the amplifier block is placed onto the end wall 11a of the cup-shaped metallic case 11 with the vibratory diaphragm 13 facing forward until the printed-circuit board 16 is fully received in the metallic case 11. In this instance, the gate terminal 15b (Fig. 1) is received in the recess 12a in the metal ring 12 and firmly gripped by and between the metal ring 12 and the printed-circuit board 16. Thereafter, an open end edge of the cup-shaped

metallic case 11 is bent inwardly into an inwardly curled edge 11e (Fig. 1) firmly clinched over and around a peripheral edge of the printed-circuit board 16. An electret condenser microphone identical to one shown in Fig. 1 is thus completed.

Fig. 3 shows an equivalent electric circuit diagram of the electret condenser microphone shown in Fig. 1. When the vibratory diaphragm 13 is displaced by sound pressures impinging thereon through the sound-receiving apertures 11d in the end wall 11a of the metallic case 11, the vibratory diaphragm 13 produces a capacitance change between the diaphragm 13 and the bulged central portion 11c of the end wall 11a that jointly form the condenser 18. The electrical output of the condenser 18 variable with the motion of the diaphragm 13 is amplified through impedance conversion by the FET 15, then the amplified output appears between an output terminal (OUT) and an earth terminal (E). In the electric circuit shown in Fig. 3, a resistor designated by R is connected at its one end to a DC power supply (+V) and at the other end to the drain terminal (D) of FET 15. Likewise, a capacitor designated by C is connected at its one end to the output terminal (OUT) and at the other end to the drain terminal (D) of FET 15.

Fig. 4 shows a modified form of the tubular metal ring 12 which is substantially the same of the metal ring 12 shown in Fig. 1 with the exception that one end face of the modified metal ring 12 is toothed and has a plurality of alternate radial recesses 12a-1 and ribs 12a-2 circumferentially spaced at equal intervals. When the metal ring 12 is assembled with the amplifier block, the gate terminal 15b (Fig. 1) of FET 15 is received in one of the recesses 12a-1 and firmly gripped by and between the metal ring 12 and the printed-circuit board 16.

A modified tubular metal ring 12 shown in Fig. 5 is flat at its opposite end faces. The modified metal ring 12 is used in combination with a circular disc 12b fixedly connected to one end face of the metal ring 12. The disc 12b is formed of an insulating material and has a rectangular central opening 12b-1 and a radial groove 12b-2 extending from the central opening 12b-1 to an outer peripheral surface of the disc 12b. When the amplifier block is assembled with the metal ring 12 to which the disc 12b has been connected, the FET 15 is partly received in the central opening 12b-1 of the disc 12b and the gate terminal 15b of FET 15 firmly retained in the radial groove 12b-2 by and between the metal ring 12 and the printed-circuit board 16.

Fig. 6 shows another modified form of the tubular metal ring 12 according to the present invention. The modified metal ring 12 is formed of an elongate sheet metal 12c shown in Fig. 7(a) bent or curled into a tubular ring shape. The elongate sheet metal 12c has a plurality of recesses 12c-1 formed along one longitudinal edge thereof. Opposite end edges 12c-2 of the

sheet metal 12c are beveled as shown in Fig. 7(b) so that the beveled end edges 12c-2 can be met closely together at a joint area 12c-3 (Fig. 6) when the sheet metal 12c is shaped into a tubular form through a 2-stage curing operation. At a first stage of the curing, the sheet metal 12c is bent about a mandrel (not shown) into a U shape as indicated by broken lines in Fig. 8. Then, at a second or final stage of the curing, the U-shaped sheet metal 12c is further bent around the mandrel into a tubular shape. In this instance, the beveled end edges 12c-2 of the sheet metal 12c engage flatwise together at the joint area 12c-3 without a clearance therebetween. The tubular metal ring 12 thus obtained then supports on its flat end face a vibratory diaphragm 13. During assembly with an amplifier block, the gate terminal 15b (Fig. 1) of a FET 15 is received in one of the recesses 12c-1 and firmly retained by and between the metal ring 12 and a printed-circuit board 16 of the amplifier block. The metal ring 12 formed by curing or bending can be manufactured less costly than both of the metal ring 12 shown in Fig. 4 and the combination of the metal ring 12 and the disc 12b shown in Fig. 5.

Referring back to Fig. 1, the vibratory diaphragm 13 carried on one end face of the metal ring 12 is held against the inside surface of the end wall 11a. Since the respective outer peripheral edges of the vibratory diaphragm 13 and the metal ring 12 are located closely to an annular side wall 11f of the cup-shaped metallic case 11, the deposited metal film 13a of the vibratory diaphragm 12 or the metal ring 12 may engage an annular side wall 11f of the metallic case 11, causing a short or insulation failure. In order to avoid shorting, there is provided a sloped annular surface 11g (Fig. 9) at an inside corner defined by and between the end wall 11a and the side wall 11f of the metallic case 11. When the metal ring 12 as it is inserted into the metallic case 11 is displaced off center relative to the metallic case 11, the outer peripheral edge of the vibratory diaphragm 13 engages the sloped surface 11g of the metallic case 11 whereupon the vibratory diaphragm 13 and the metal ring 12 are caused by the sloped surface 11g to move back toward the central axis of the metallic case 11. With the sloped surface 11g thus provided, the deposited metal film 13a and the metal ring 12 are held out of contact with the side wall 11f of the metallic case 11 and hence an objectionable shorting or insulation failure can be avoided.

Fig. 9(b) shows a modified arrangement for insulation failure protection, which includes an annular step 12d formed at an upper peripheral edge of the metal ring 12. With the annular step 12d thus provided, the diameter of the vibratory diaphragm 13 exceeds the outside diameter of the stepped upper peripheral edge of the metal ring 12 and hence an outer peripheral edge portion 13b of the vibratory diaphragm 13 projects radially outwardly from the step-

ped upper peripheral edge of the metal ring 12. When the metal ring 12 is inserted into the metallic case 11, the outer peripheral edge portion 13b of the vibratory diaphragm 13 engages an sloped annular surface 11g of the metallic case 11, then is caused to bend downwardly toward the annular step 12d. The outer peripheral edge portion 13b thus bent acts as an insulator between the deposited metal film 13a and the metallic case 11 and also between the metal ring 12 and the metallic case 11.

Another modified form of the insulation failure protecting arrangement shown in Fig. 9(c) includes a vibratory diaphragm 13 having a diameter larger than the outside diameter of a metal ring 12. With this difference in diameter, an outer peripheral edge portion 13b of the vibratory diaphragm 13 projects outwardly from the outer periphery of the metal ring 12. The outer peripheral edge portion 13b is bent toward the metal ring 12 when it engages the sloped annular surface 11g of the metallic case 11. The deposited metal film 13a of the vibratory diaphragm 13 and the metal ring 12 are held out of contact with the metallic case 11 by means of an insulating member which is composed of the bent outer peripheral edge portion 13b of the vibratory diaphragm 13.

Fig. 10 shows a modified electret condenser microphone according to the present invention. The modified electret condenser microphone similar to the electret condenser microphone shown in Fig. 1 but differs therefrom in that the end wall 11a of a cup-shaped metallic case 11 has a plurality of projections (three in the illustrated embodiment as shown in Fig. 11) 11h on its inside surface. The projections 11h have a height of about 40μ to 60μ and urge portions of the vibratory diaphragm 13 downwardly away from the end wall 11a so as to provide an air gap 19 between the end wall 11a and the vibratory diaphragm 13. The end wall 11a and the vibratory diaphragm 13 thus separated by the air gap 19 jointly form a condenser or capacitor 18 whose capacitance is variable with the motion of the vibratory diaphragm 13. Stated more specifically, the cup-shaped metallic case 11 is made of aluminum, for example, and has a plurality (four in the illustrated embodiment) of sound-receiving apertures 11d formed in the end wall 11a in staggered relation to the projections 11h. The projections 11h are formed by inwardly swelling portions of the end wall 11a by means of a tool such as a punch. The projections 11h are disposed in a same circle having a center aligned with the central of the end wall 11a and they are circumferentially spaced at equal angular intervals. An tubular metal ring 12 made for example of stainless steel is disposed in the metallic case 11 and carries on its one end face the vibratory diaphragm 13. The vibratory diaphragm 13 is formed of a fluorine resin and has on its one surface a deposited metal film 13a made of nickel. The vibratory diaphragm 13 is bonded to the end surface of the metal

ring 12 with the deposited metal film 13a interposed therebetween. An impedance conversion element comprised of an field-effect transistor 15 is mounted on a printed-circuit board 16 and has a drain terminal, not shown, and a source terminal 15a extending through holes in the printed-circuit board 16 and soldered as at 17 to conductors formed on the under surface of the printed-circuit board 16. The field-effect transistor 15 further has a gate terminal 15b received in one of a plurality of circumferentially spaced recesses 12a-1 formed in an opposite end face of the metal ring 12. The gate terminal 15b thus received in the recess 12a-1 is firmly gripped by and between the metal ring 12 and the printed-circuit board 16. The printed-circuit board 16 is clinched with an inwardly curled open end edge 11e of the cup-shaped metallic case 11, with the field-effect transistor 15 disposed within an internal space of the metal ring 12.

In assembly, the vibratory diaphragm 13 is bonded to one end face of the metal ring 12, then the an amplifier unit or block composed of the field-effect transistor 15 mounted on the printed-circuit board 16 is secured to the opposite end face of the metal ring 12. In this instance, the gate terminal 15b of the field-effect transistor 15 is firmly retained in the recess 12a-1 by and between the metal ring 12 and the printed-circuit board 16. The metal ring 12 assembled with the amplifier block is inserted into the metallic case 11 with the vibratory diaphragm 13 facing forward. During that time, a sloped annular surface 11g of the metallic case 11 centers the metal ring 12 upon engagement with an outer peripheral edge of the vibratory diaphragm 13. Then, an open end edge of the cup-shaped metallic case 11 is bent into an inwardly curled edge 11e firmly clinched over and around the peripheral edge portion of the printed-circuit board 16, thereby assembling the electret condenser microphone shown in Fig. 10. In this assembled condition, the projections 11h on the end wall 11a urge portions of the vibratory diaphragm 13 away from the end wall 11a so as to provide the air gap 19 between the end wall 11a and the vibratory diaphragm 13 that constitute fixed and movable electrodes of the variable condenser 18.

Fig. 12 shows a portion of a modified electret condenser microphone which is substantially the same as the one shown in Fig. 10 except the position of the projections 11h. The projections 11h are disposed on a same circle whose center is aligned with the center of the end wall 11a of the cup-shaped metallic case 11. This circle has a diameter such that the projections 11h are located closely to the inner peripheral edge of the metal ring 12. The projections 11h thus arranged serve as positioning means for centering the metal ring 12 with respect to the central axis of the metallic case 11. With the positioning means thus provided, the deposited metal film 13a of the vibratory diaphragm 13 and the metal ring 12 is held out

of contact with the metallic case 11.

Another modified electret condenser microphone shown in Fig. 13 is substantially identical to the one shown in Fig. 10 with the exception that the end wall 11a of the cup-shaped metallic case 11 has only one projection 11h on its inside surface. The projection 11 is located at the center of the end wall 11a and urges a central portion of the vibratory diaphragm 13 away from the end wall 11a so as to define an air gap 18 between the end wall 11a and the vibratory diaphragm 13.

Fig. 14 shows a modified form of the electret condenser microphone according to the embodiment shown in Fig. 13. The modified electret condenser microphone includes a ring plate 20 bonded at its one side to an outer peripheral edge of the vibratory diaphragm 13 and secured at its opposite side to a recessed end surface of the tubular metal ring 12.

A still further modified electret condenser microphone shown in Fig. 15 includes a spacer ring 21 disposed between an end wall 11a of a cup-shaped metallic case 11 and the vibratory diaphragm 13 bonded to one end face of the metal ring 12, so as to provide an air gap 19 between the end wall 11a and the vibratory diaphragm 13 that constitute fixed and movable electrodes of a variable condenser or capacitor 18. The spacer ring 21 thus provided obviates the need for the gap-forming recess 11b or the gap-forming projection 11h as required in the electret condenser microphones according to any of the foregoing embodiments.

As described above, at least a portion of the end wall 11a of the cup-shaped metallic case 11 constitutes a fixed electrode of a condenser 18. The use of such end wall 11a makes a separate fixed electrode unnecessary and hence the number of components of the electret condenser microphone is reduced. Consequently, the electret condenser microphone is simple in construction and suited for automated production, and hence can be manufactured at a low cost. Furthermore, since the fixed electrode is no longer required to be disposed in the metallic case 11, there is provided a large room available for the formation of a rear cavity 14 behind the vibratory diaphragm 13. With this large rear cavity 14, the sensitivity of the microphone is improved. Accordingly, when manufacturing an electret condenser microphone having a same sensitivity as the conventional one, a substantial reduction of the overall size of the microphone can be obtained.

Obviously various minor changes and modifications of the present invention are possible in the light of the above teaching. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

Claims

1. An electret condenser microphone comprising a cup-shaped metallic case (11) including an end wall (11a) having a plurality of sound-receiving apertures (11d) formed therein, a metal ring (12) received in said metallic case (11), and a vibratory diaphragm (13) having on one surface thereof a deposited metal film (13a) being bonded to an end face of said metal ring (12), said vibratory diaphragm (13) confronting said end wall (11a) with an air gap (19) defined between at least part of said end wall (11a) and at least part of said diaphragm (13), said metal film (13a) forming a movable electrode of a condenser also comprising a fixed counter electrode
characterised in that said fixed counter electrode comprises at least a part of said end wall (11a) of said metallic case (11).
2. An electret condenser microphone as claimed in claim 1, wherein a portion (11c) of the inside surface of said end wall (11a) is recessed and, except for said recessed portion (11c) said end wall (11a) is held in contact with said vibratory diaphragm (13), said recessed portion (11c) constituting said fixed counter electrode.
3. An electret condenser microphone as claimed in claim 1 wherein said end wall (11a) has a projection (11h) on its inside surface, said projection (11h) being held in pressured contact with a portion of said vibratory diaphragm (13) to urge said vibratory diaphragm away from said end wall (11a) so as to provide said air gap (19) between said at least part of said end wall (11a) and said at least part of said vibratory diaphragm (13).
4. An electret condenser microphone as claimed in claim 1, 2 or 3, wherein said metal ring (12) is formed from sheet metal (12c) bent into a tubular ring form.
5. An electret condenser microphone as claimed in claim 1, 2, 3 or 4, further including a printed-circuit board (16) having an impedance conversion element (15) mounted thereon, said printed-circuit board (16) being received in said cup-shaped metallic case (11) and secured to an opposite end face of said metal ring (12), said impedance conversion element (15) having a terminal (15b) held in contact with said metal ring (12).
6. An electret condenser microphone as claimed in claim 5, wherein said impedance conversion element (15) comprises a field-effect transistor, said field-effect transistor (15) having a gate terminal (15b) held in contact with said metal ring (12).
7. An electret condenser microphone as claimed in claim 5 or 6, said impedance conversion element (15) being disposed in said cup-shaped metallic case (11), said cup-shaped metallic case (11) having an inwardly curled open end edge (11e) firmly clinched over and around a peripheral edge of said printed-circuit board (16).
8. An electret condenser microphone as claimed in claim 5, 6 or 7 wherein said metal ring (12) has a recess (12a; 12a-1; 12c-1) in said opposite surface thereof, said terminal (15b) of said impedance conversion element (15) being received in said recess (12a, 12a-1; 12c-1) and gripped by and between said metal ring (12) and said printed-circuit board (16).
9. An electret condenser microphone as claimed in claim 5, 6 or 7 further including a circular disc (12b) formed of an insulating material and secured between said opposite end face of said metal ring (12) and said printed-circuit board (16), said circular disc (12b) having a central opening (12b-1) and a radial groove (12b-2) extending from said central opening (12b-1) to a peripheral surface of said circular disc (12b), said terminal (15b) of said impedance conversion element (15) being received in said radial groove (12b-2) and gripped by and between said metal ring (12) and said printed-circuit board (16).
10. An electret condenser microphone as claimed in any one of the preceding claims wherein said cup-shaped metallic case (11) has a sloped surface (11g) at an inside corner defined between said end wall (11a) and an annular side wall (11f) of said metallic case (11).
11. An electret condenser microphone as claimed in any one of the preceding claims wherein said vibratory diaphragm (13) has a diameter larger than the outside diameter of said metal ring (12) and includes a peripheral edge portion (13b) projecting outwardly from said metal ring (12) and bent toward said metal ring (12).
12. An electret condenser microphone as claimed in any one of the preceding claims wherein said end wall (11a) has a plurality projections (11h) on its inside surface, and projections (11h) urging portions of said vibratory diaphragm (13) away from said end wall (11a) so as to provide said air gap (19) between said vibratory diaphragm (13) and said end wall (11a), said projections (11h) constituting means for positioning said metal ring (12) relative to said metallic case (11).
13. An electret condenser microphone as claimed in

any one of the preceding claims further including a spacer ring (21) disposed between said end wall (11a) of said metallic case (11) and said vibratory diaphragm (13).

Patentansprüche

1. Elektret- Kondensatormikrofon mit einem becherförmigen Metallmantel (11), der eine Stirnplatte (11a) mit einer Vielzahl von in diese eingearbeiteten Schalleinlaß- Öffnungen (11d) aufweist, mit einem von dem Mantel (11) aufgenommenen Metallring (12) und mit einer Schwingmembran (13), auf deren einer Oberfläche ein Metallfilm (13a) aufgebracht ist, der an eine Stirnfläche des Metallrings (12) gebondet ist, wobei die Schwingmembran (13) gegenüber der Stirnplatte (11a) mit einem Luftspalt (19) zwischen wenigstens einem Teil der Stirnplatte (11a) und wenigstens einem Teil von der Schwingmembran (13) festgelegt ist und wobei der Metallfilm (13a) eine bewegliche Elektrode eines Kondensators bildet, zu dem auch eine feststehende Gegenelektrode zählt, **dadurch gekennzeichnet**, daß zu der feststehende Gegenelektrode wenigstens ein Teil der Stirnplatte (11a) des Mantels (11) gehört.
 2. Kondensatormikrofon nach Anspruch 1, bei dem ein Abschnitt (11c) der Innenfläche der Stirnplatte (11a) vertieft ist und bei dem die Stirnplatte (11a) mit Ausnahme des vertieften Abschnitts (11c) in Kontakt mit der Schwingmembran (13) gehalten ist, wobei der vertiefte Abschnitt (11c) die feststehende Gegenelektrode bildet.
 3. Kondensatormikrofon nach Anspruch 1, dessen Stirnplatte (11a) auf seiner Innenfläche einen Vorsprung (11h) aufweist, der mit einem Abschnitt der Schwingmembran (13) in Druckverbindung steht, um die Schwingmembran (13) von der Stirnplatte (11a) wegzudrängen und so den Luftspalt (19) zwischen der wenigstens einfach vorgesehenen Stirnplatte (11a) und der wenigstens einfach vorgesehenen Schwingmembran (13) zu schaffen.
 4. Kondensatormikrofon nach Anspruch 1, 2 oder 3, dessen Metallring (12) aus Blech besteht und zu einer dünnflächigen Ringform gebogen ist.
 5. Kondensatormikrofon nach Anspruch 1, 2, 3 oder 4, in das des weiteren eine mit einem Impedanzwandlerelement (15) bestückte Leiterplatte (16) eingebaut ist, die von dem becherförmigen Metallmantel (11) umschlossen ist, und die an einer gegenüberliegenden Stirnfläche des Metallrings
- (12) gesichert ist, wobei das Impedanzwandlerelement (15) über einen Anschluß (15b) mit dem Metallring (12) Kontakt hat.
 6. Kondensatormikrofon nach Anspruch 5, dessen Impedanzwandlerelement (15) über einen Feldeffekttransistor (15) verfügt, dessen Gate- Anschluß (15b) zu dem Metallring (12) Kontakt hat.
 7. Kondensatormikrofon nach Anspruch 5 oder 6, dessen Impedanzwandlerelement (15) in dem becherförmigen Metallmantel (11) untergebracht ist, der nach innen mit einer eingerollten offenen Stirnumrandung (11e) die fest über und um eine Randkante der Platine geklammert ist.
 8. Kondensatormikrofon nach Anspruch 5, 6 oder 7, dessen Metallring (12) eine Ausnehmung (12a, 12a₋₁, 12c₋₁) in seiner gegenüberliegenden Oberfläche aufweist, wobei der Anschluß (15) von der Ausnehmung (12a, 12a₋₁, 12c₋₁) aufgenommen wird und von und zwischen dem Metallring (12) und der Platine (16) eingefasst ist.
 9. Kondensatormikrofon nach Anspruch 5, 6 oder 7, das des weiteren eine Kreisscheibe (12b) aus einem Isoliermaterial enthält, die an der gegenüberstehenden Stirnfläche des Metallrings (12) und an der Platine (16) gehalten ist, wobei die Kreisscheibe (12b) mit einer Mittelöffnung und einer radialen Kerbe (12b₋₂) versehen ist, die sich von der Mittelöffnung (12b₋₁) zur äußeren Oberfläche der Kreisscheibe (12b) erstreckt, wobei der Anschluß (15b) des Impedanzwandlerelements (15) und von der radialen Kerbe aufgenommen und zwischen Metallring (12) Platine (16) eingespannt ist.
 10. Kondensatormikrofon nach einem der vorstehenden Ansprüche, dessen becherförmiger Metallmantel (11) eine ansteigende Oberfläche (11g) an einer zwischen der Stirnwand (11f) und einer Seitenwand (11f) des Metallmantels (11) festgelegten Innenecke aufweist.
 11. Kondensatormikrofon nach einem der vorstehenden Ansprüche, dessen Schwingmembran (13) einen Durchmesser aufweist, der größer als der Metallring (12) ist und einen äußeren Endabschnitt (13b) enthält, der nach außen aus dem Metallring (12) hervorspringt und zum Metallring (12) gebogen ist.
 12. Kondensatormikrofon nach einem der vorstehenden Ansprüche, dessen Stirnplatte (11a) eine Vielzahl von Vorsprüngen (11h) auf ihrer Innenfläche aufweist, und die Vorsprünge (11h) Ab-

schnitte der Schwingmembran (13) von der Stirnwand wegdrängen, um so einen Luftspalt (19) zwischen der Schwingmembran (13) und der Stirnplatte (11a) zu schaffen, wobei die Vorsprünge (11h) Mittel zur Positionierung des Metallrings (12) bezüglich dem Metallmantel (11) bilden.

13. Kondensatormikrofon nach einem der vorstehenden Ansprüche, mit einem zwischen der Stirnplatte (11a) des Metallmantels (11) und der Schwingmembran (13) angeordneten Abstandsring (21).

Revendications

1. Microphone à électret comprenant un boîtier métallique (11) en forme de cuvette comprenant une paroi d'extrémité (11a) comportant une pluralité d'ouvertures (11d) réceptrices de sons qui y sont formées, une bague métallique (12) logée dans ledit boîtier métallique (11), et un diaphragme vibrant (13) comportant, sur une de ses surfaces, un film métallique déposé (13a) qui est accolé à une face d'extrémité de ladite bague métallique (12), ledit diaphragme vibrant (13) se trouvant en regard de ladite paroi d'extrémité (11a), un intervalle d'air (19) étant défini entre au moins une partie de la paroi d'extrémité précitée (11a) et au moins une partie dudit diaphragme (13), ledit film métallique (13a) formant une électrode mobile d'un condensateur comprenant aussi une contre-

électrode fixe caractérisé en ce que ladite contre-électrode fixe comprend au moins une partie de ladite paroi d'extrémité (11a) dudit boîtier métallique (11).

2. Microphone à électret selon la revendication 1, dans lequel une partie (11c) de la surface intérieure de ladite paroi d'extrémité (11a) est évidée et, à l'exception de ladite partie évidée (11c), ladite paroi d'extrémité (11a) est maintenue en contact avec ledit diaphragme vibrant (13), ladite partie évidée (11c) constituant ladite contre-électrode fixe.

3. Microphone à électret selon la revendication 1, dans lequel ladite paroi d'extrémité (11a) comporte une saillie (11h) sur sa surface intérieure, ladite saillie (11h) étant maintenue en contact sous pression avec une partie dudit diaphragme vibrant (13) de manière à éloigner ledit diaphragme vibrant de ladite paroi d'extrémité (11a) afin de former ledit espace d'air (19) entre ladite partie, au nombre d'au moins une, de ladite paroi d'extrémité (11a) et ladite partie, au nombre d'au

moins une, dudit diaphragme vibrant (13).

4. Microphone à électret selon la revendication 1, 2 ou 3, dans lequel ladite bague métallique (12) est formée à partir d'une feuille métallique (12c) courbée de manière à prendre la forme tubulaire d'une bague.

5. Microphone à électret selon la revendication 1, 2, 3 ou 4, comprenant, en outre, une carte (16) de circuits imprimés comportant un élément (15) de conversion d'impédance monté sur cette carte, ladite carte (16) de circuits imprimés étant logée dans ledit boîtier métallique (11) en forme de cuvette et étant fixée à une face d'extrémité opposée de ladite bague métallique (12), ledit élément (15) de conversion d'impédance comportant une borne (15b) maintenue en contact avec ladite bague métallique (12).

6. Microphone à électret selon la revendication 5, dans lequel ledit élément (15) de conversion d'impédance comprend un transistor à effet de champ, ledit transistor (15) à effet de champ comportant une borne (15b) de grille maintenue en contact avec ladite bague métallique (12).

7. Microphone à électret selon la revendication 5 ou 6, ledit élément (15) de conversion d'impédance étant disposé dans ledit boîtier métallique (11) en forme de cuvette, ledit boîtier métallique (11) en forme de cuvette comportant un bord (11e) d'extrémité ouverte, qui est recourbé vers l'intérieur et est rabattu fermement sur le bord périphérique de ladite carte (16) de circuits imprimés et autour de ce bord.

8. Microphone à électret selon la revendication 5, 6 ou 7, dans lequel ladite bague métallique (12) comporte un évidement (12a; 12a-1; 12c-1) dans sa surface opposée précitée, ladite borne (15b) dudit élément (15) de conversion d'impédance étant logée dans ledit évidement (12a, 12a-1; 12c-1) et étant serrée par, et entre, ladite bague métallique (12) et ladite carte (16) de circuit imprimé.

9. Microphone à électret selon la revendication 5, 6 ou 7, comprenant, en outre, un disque (12b) formé d'un matériau isolant et fixé entre ladite face d'extrémité opposée de ladite bague métallique (12) et ladite carte (16) de circuits imprimés, ledit disque (12b) comportant une ouverture centrale (12b-1) et une rainure radiale (12b-2) s'étendant depuis ladite ouverture centrale (12b-1) jusqu'à la surface périphérique dudit disque (12b), ladite borne (15b) dudit élément (15) de conversion d'impédance étant logée dans ladite rainure ra-

diale (12b-2) et étant serrée par, et entre, ladite bague métallique (12) et ladite carte (16) de circuits imprimés.

10. Microphone à électret selon l'une quelconque des revendications précédentes, dans lequel ledit boîtier métallique (11) en forme de cuvette comporte une surface inclinée (11g) à l'endroit d'un angle intérieur défini entre ladite paroi d'extrémité (11a) et une paroi latérale annulaire (11a) dudit boîtier métallique (11). 5 10
11. Microphone à électret selon l'une quelconque des revendications précédentes, dans lequel ledit diaphragme vibrant (13) a un diamètre plus grand que le diamètre extérieur de ladite bague métallique (12) et comprend une partie marginale périphérique (13b) qui fait saillie vers l'extérieur depuis ladite bague métallique (12) et est coudée en direction de ladite bague métallique (12). 15 20
12. Microphone à électret selon l'une quelconque des revendications précédentes, dans lequel ladite paroi d'extrémité (11a) comporte une pluralité de saillies (11h) sur sa surface intérieure, et ces saillies (11h) poussent des parties dudit diaphragme vibrant (13) de manière à les éloigner de ladite paroi d'extrémité (11a) afin de former ledit espace d'air (19) entre le diaphragme vibrant (13) et la paroi d'extrémité (11a), lesdites saillies (11h) constituant des moyens pour positionner la bague métallique (12) par rapport au boîtier métallique (11). 25 30
13. Microphone à électret selon l'une quelconque des revendications précédentes, comprenant, en outre, une bague d'espacement (21) disposée entre ladite paroi d'extrémité (11a) du boîtier métallique (11) et ledit diaphragme vibrant (13). 35 40

40

45

50

55

10

FIG. 1

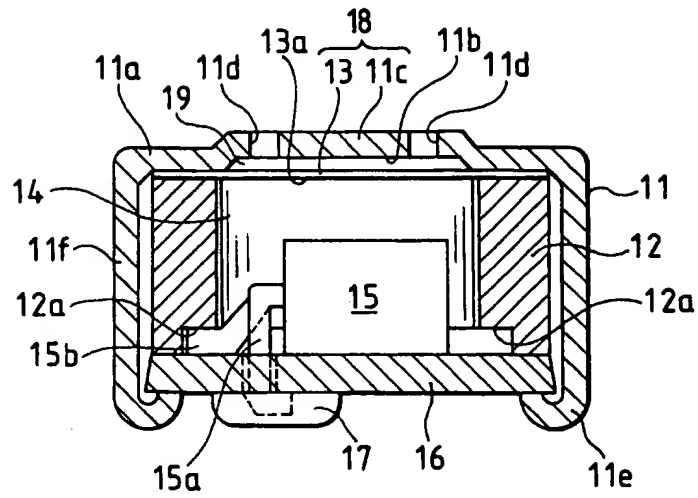


FIG. 2

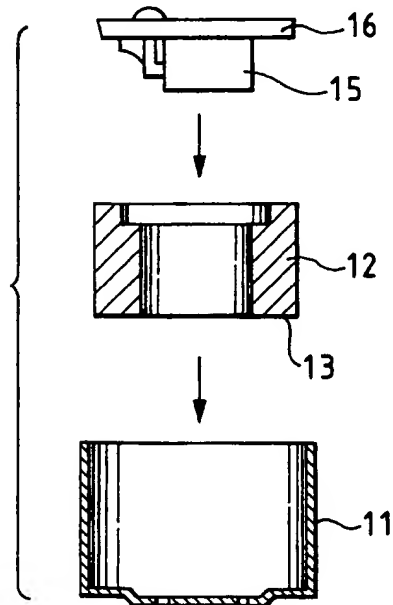


FIG. 3

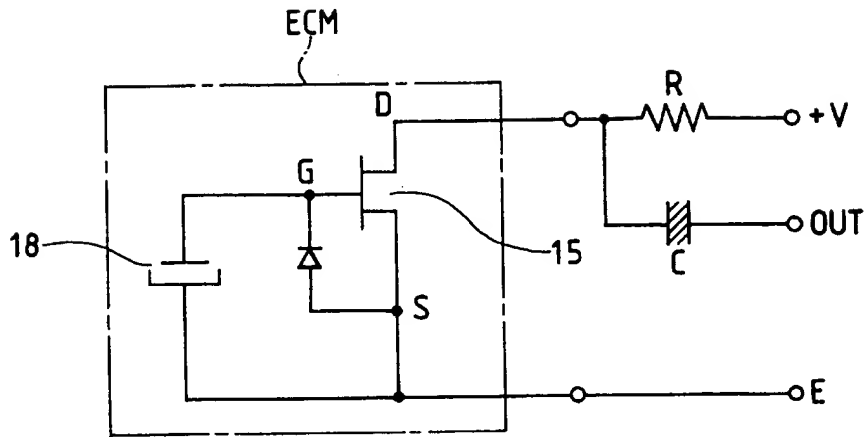


FIG. 4

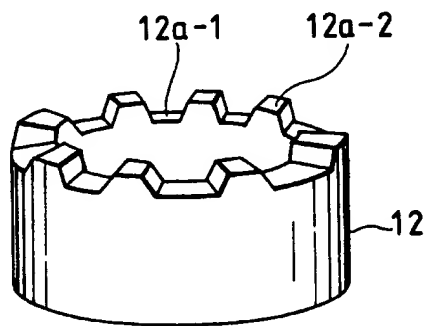


FIG. 5

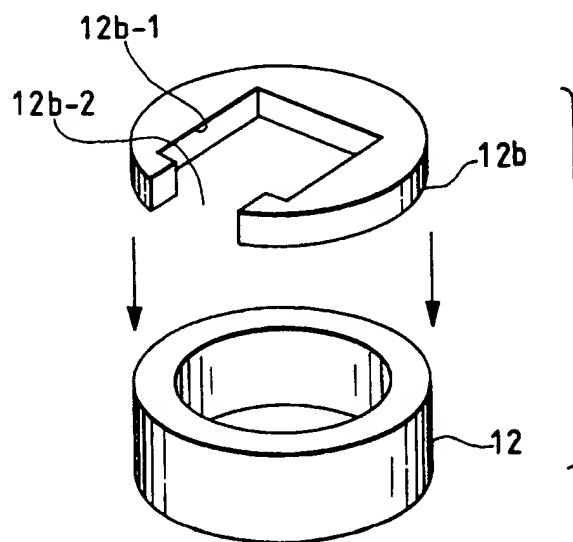


FIG. 6

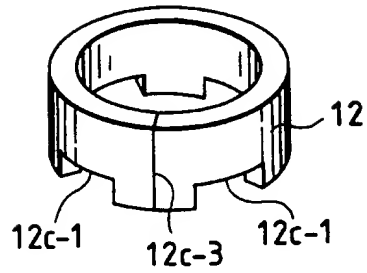


FIG. 7(a)

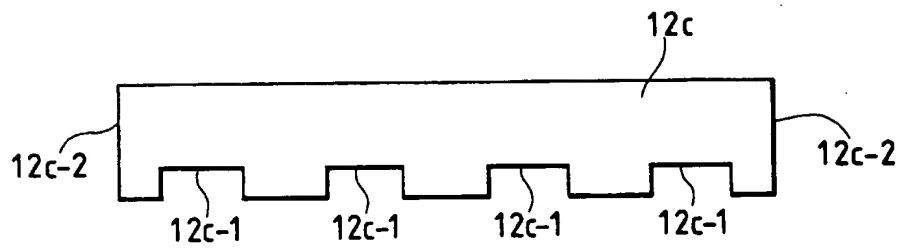


FIG. 7(b)

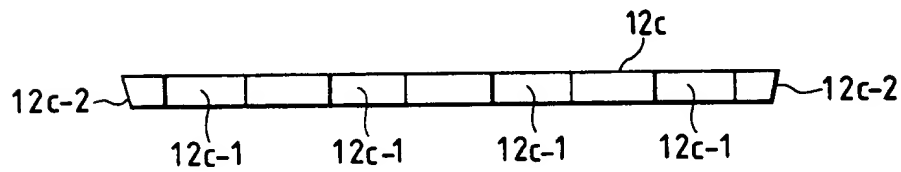


FIG. 8

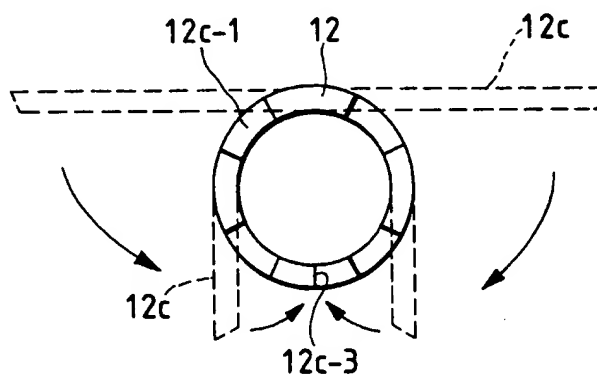


FIG. 9(a)

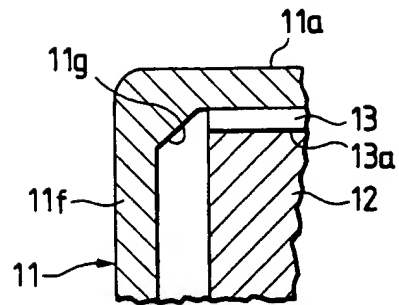


FIG. 9(b)

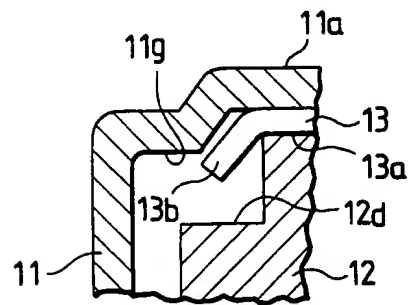


FIG. 9(c)

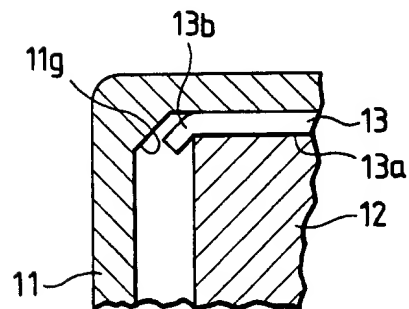


FIG. 10

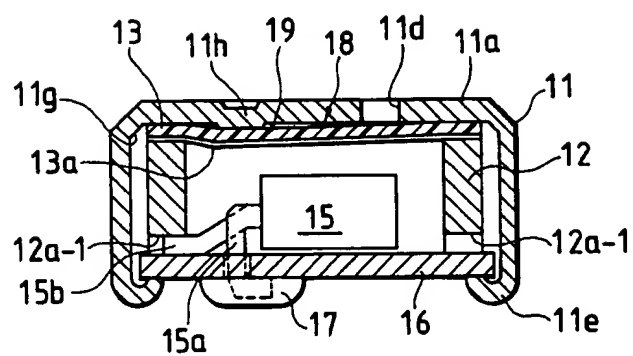


FIG. 11

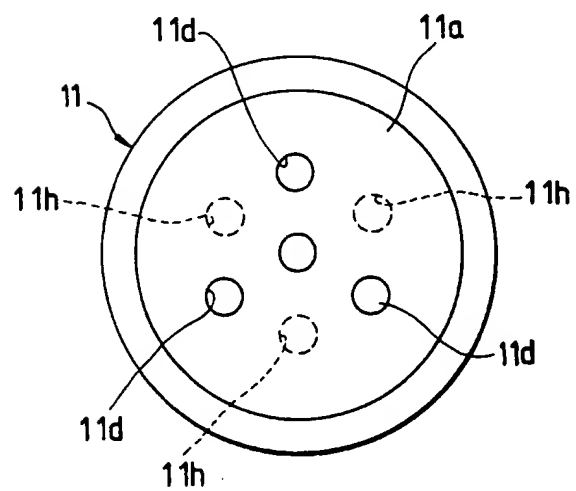


FIG. 12

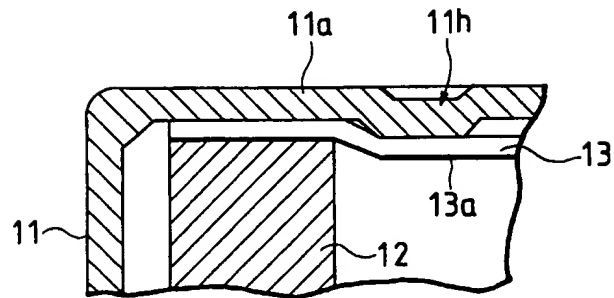


FIG. 13

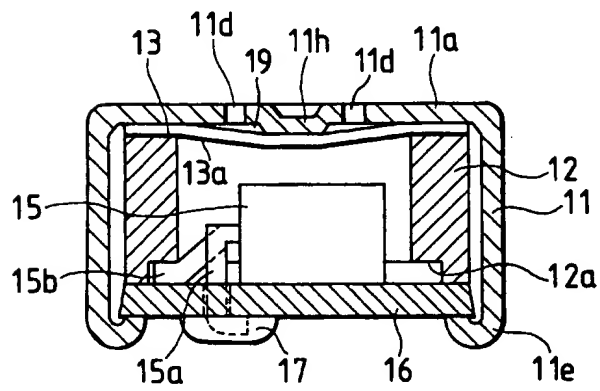


FIG. 14

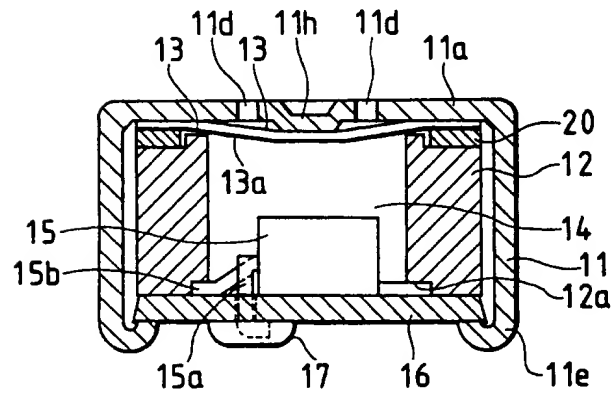


FIG. 15

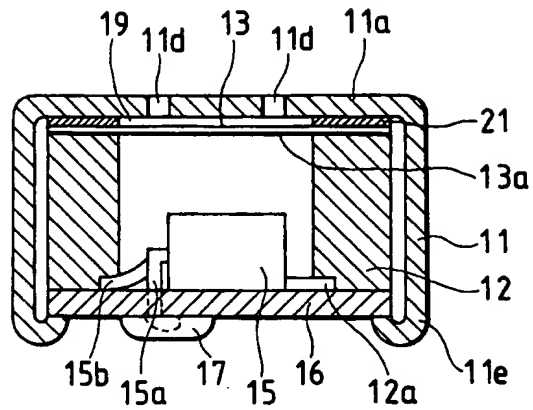


FIG. 16
PRIOR ART

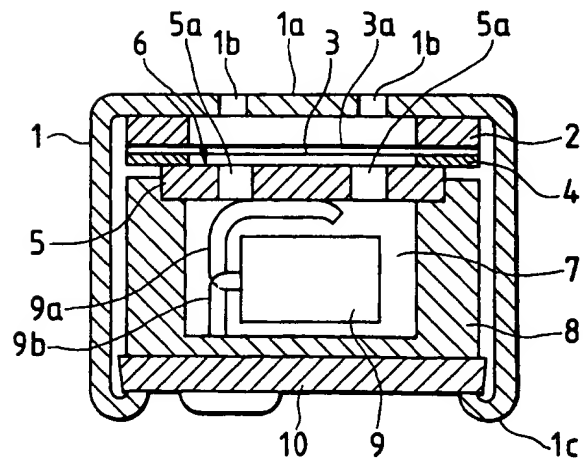


FIG. 17
PRIOR ART

